A STUDY ON THE PREDICTORS OF METABOLIC SYNDROME IN ADOLESCENT SCHOOL CHILDREN IN A SEMIURBAN SETUP

Dissertation submitted to

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MD BRANCH – I

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CERTIFICATE

Certified that this dissertation entitled **"A study on the predictors of metabolic syndrome in adolescent school children in a semi urban setup**" is a bonafide work done by **Dr.N.MUHASUDEEN,** Postgraduate, Chengalput Medical College during the academic year 2007- 2010.

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I, Dr. N. MUHASUDEEN, solemnly declare that this dissertation entitled **"A Study on the Predictors of Metabolic Syndrome in Adolescent School Children in a Semiurban Setup"** has been prepared by me.

This is submitted to **The Tamilnadu Dr. M. G. R Medical University, Chennai** in partial fulfillment of the rules and regulations for the award of M.D Degree (Branch I) General medicine.

Place : Chengalput **Dr. N. MUHASUDEEN**

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CONTENTS

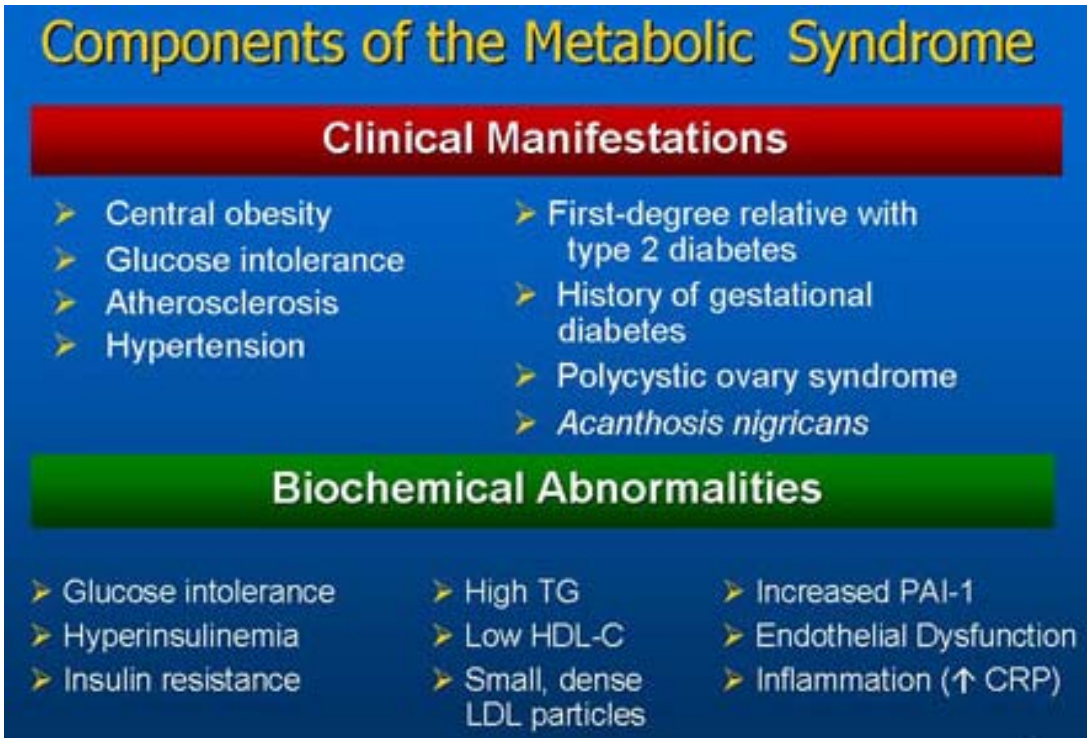
INTRODUCTION

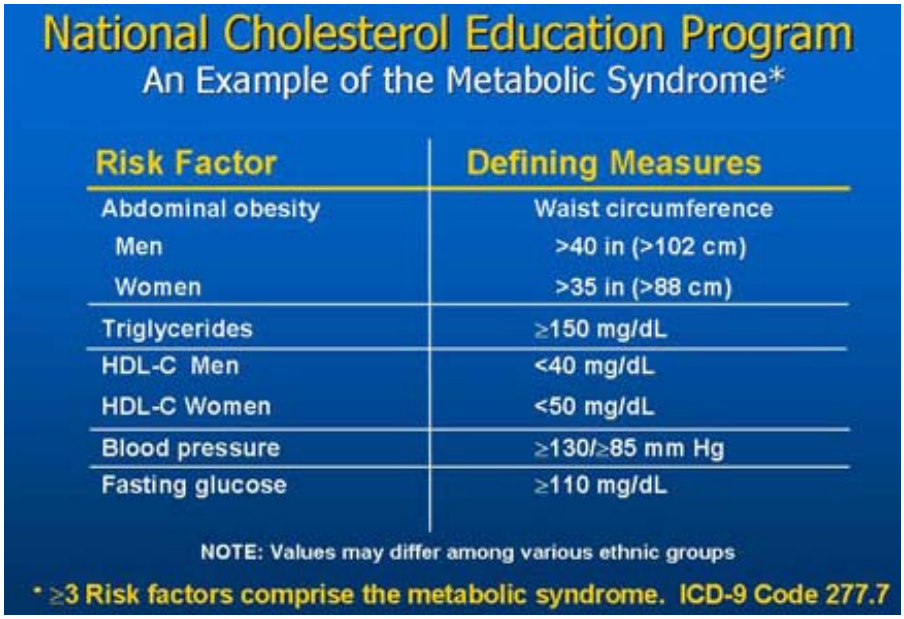
The clustering of insulin resistance, dysglycemia , dyslipidemia & hypertension was originally defined as syndrome X in 1988 by Reaven. Definitions of metabolic syndrome that also include a measure of central obesity have been developed between 1999 & 2001 by the WHO, European Group for the Study of Insulin Resistance & National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III). The ATP III criteria also recognized the association between the above factors & both pro inflammatory & prothrombotic states as reflected by increased CRP & plasminogen activator inhibitor levels, but these are not required for definition. The factors involved in each of these definitions are summarized in Table 1.

	WHO Consultation 1999	EGIR 1999	NCEP ATP III 2001
Diagnostic criteria	IGT or DM and/or insulin resistance & 2 of other factors	Presence of fasting hyperinsulinemia & two of other factors	3 or more of the following factors (TGL & HDL counted separately)
Central obesity	WHR > 0.9 (men) 0.85 (women) and/or BMI>30	Waist ≥94cm(men) ≥80cm(women)	Waist≥102cm(men) ≥88cm(women)
Blood Pressure (mm Hg)	≥140/90	≥140/90 or treated for hypertension	>130/85 or treated for hypertension
Dyslipidemia (mmol/L)	TGL ≥1.7 mmol/L HDL< 0.9 (men), <1.0 (women)	TGL> 2.0 or HDL < 1.0 or treated for dyslipidemia	TGL≥1.7;HDL <1.0(men) <1.3 (women)
Dysglycemia (mmol/L)	Fasting glucose≥6.1 and/or 2 h post challenge glucose ≥7.8 on diabetes	Fasting plasma glucose >6.1,but non diabetic	Fasting plasma glucose ≥6.1
Insulin resistance	Glucose uptake during hyperinsulinemic euglycemic clamp in lowest quartile for population	Presence of fasting hyperinsulinemia (i.e among the highest 25% of the non diabetic population)	Not applicable
Other factors	Microalbuminuria (urinary albumin excretion rate >20 μg/min or albumin creatinine ratio >30 mg/g)	None	Not applicable

TABLE 1

The International Diabetes Federation (IDF) produced a consensus worldwide definition of the metabolic syndrome in 2005 . The criteria for this definition are a waist circumference ≥94 cm for European men & ≥80 cm for European women & 2 or more of the following: Blood pressure, TGL & HDL cut off points as for the ATPIII definition& fasting plasma glucose >5.6 mmol/L.





The IDF definition of the at risk group and the metabolic syndrome in children and adolescents is as follows:

Age group (yrs)	**Obesity (WC)**	**TGL**	**HDL -C**	**Blood pressure**	**Glucose (mmol/L) Known Type 2 DM**
6 to <10	>90th percentile	Metabolic syndrome cannot be diagnosed but further measurements have to be made if there is a family history of metabolic syndrome,T2 DM, hypertension, dyslipidemia, cardiovascular disease and obesity			
10 to < 16	>90th percentile or adult cut off if lower	>1.7 mmol/L (150 mg/dL)	<1.03 mmol/L (<40 mg/dL)	Systolic >130 Diastolic > 85 mmHg	>5.6 mmol/L (100 mg/dL)
16 & above	Use existing IDF criteria for adults				

REVIEW OF LITERATURE

The Centre for Disease Control, Atlanta has defined 'at risk of overweight' as a BMI > 85th to 94th percentile and 'overweight' as a BMI of >95th percentile. Most children experience obesity than any of the other metabolic syndrome risk factors. Therefore, obesity and insulin resistance have greater impacts on the risk of developing the syndrome than the other factors. Obesity can be viewed as a root disease, as health problems presently associated with pediatric obesity were essentially nonexistent 15 – 20 yrs ago. According to Ribeiro et al.,(2004), about 62% of boys and girls at risk for obesity are likely to experience other metabolic syndrome risk factors. Obesity has been shown to increase the likelihood of developing the metabolic syndrome in children 8 – 10 times (Harrell et al., 2006).

PREVALENCE

Most studies suggest a prevalence of the metabolic syndrome in general adult populations of 15 – 30 % & are mostly based in developed countries or urban areas of developing countries. Generally speaking, the prevalence of metabolic syndrome was similar or higher using WHO criteria when compared with the use of ATP III criteria.

Cook S et al estimated the prevalence of metabolic syndrome in adolescents 12 – 19 yrs by applying a modification of the ATP III definition for adults. The prevalence was found to be 4.2% overall (6.1 % of males and 2.1 % of females). Of adolescents with the syndrome, 73.9% were overweight and 25.2% were at risk of overweight.

De Ferranti et al examined more than 3400 children and one in ten had the metabolic syndrome.

Using a sample of adolescents from NHANES III, the overall prevalence of the metabolic syndrome in moderately obese subjects was found to be 38.7% and 49.7% in severely obese subjects by Weiss et al.

Age adjusted prevalence of overweight from national surveys (1963 to 1994) in 12 – 17 yrs age group

Population group	***Males***	***Females***
ALL races		
NHES II	3.9	4.3
NHANES I	3.8	3.6
NHANES II	6.5	5.5
NHANESIII	11.4	9.9

FACTORS INFLUENCING METABOLIC SYNDROME

AGE :

Prevalence of most individual factors within the metabolic syndrome increases with age at middle age. For e g., in the NHANESIII performed in the US, the prevalence of MS, defined using ATPIII criteria increased from 6.7%in 20 -29 yrs age group to 43.5% for 60 – 69 yr olds.

GENDER:

As central obesity is one of the factors included in the definition of the metabolic syndrome and, for a given BMI, central obesity is more common in men, prevalence is higher in men. The effect of generalized obesity is also extremely important such that in populations in which obesity is common in women, the prevalence of MS is more common in women eg, Indian, Iranian & Turkish populations. A cardiovascular risk factor survey in France showed that elevated body weight, waist girth & low HDL were significantly larger contributors in women than men, whereas systolic & diastolic BP contributed less in women and insulin, glucose & TGL made similar contributions in both sexes.

ETHNICITY:

Some ethnic groups have a higher predisposition to central obesity than others eg South Asians than Europeans.

OBESITY & FAT DISTRIBUTION:

The association of central or general obesity and MS varies with gender (Ho et al., 2001). Distribution of fat influences prevalence of MS for a given BMI. The NHANESIII study showed that prevalence of MS defined using ATPIII criteria increased from 0.9 to 3%for people with BMI in the range 18.5 – 20.9 to 9.6 to 22.5 %for people with BMI in the range 25.0 – 26.9, depending on gender and ethnicity. The influence of obesity on the prevalence of MS has also been observed in children. A detailed study of 439 obese, 31 overweight and 20 non obese children in the US showed that prevalence of MS increased with severity of obesity and around half of severely obese participants had MS (Weiss et al.,2004). Data from 12 – 19 yr old participants in NHANESIII showed that prevalence of MS varied between 0.1% for those with BMI < 85^{th} percentile to 29% for BMI>95^{th} percentile (Cook et al., 2003).

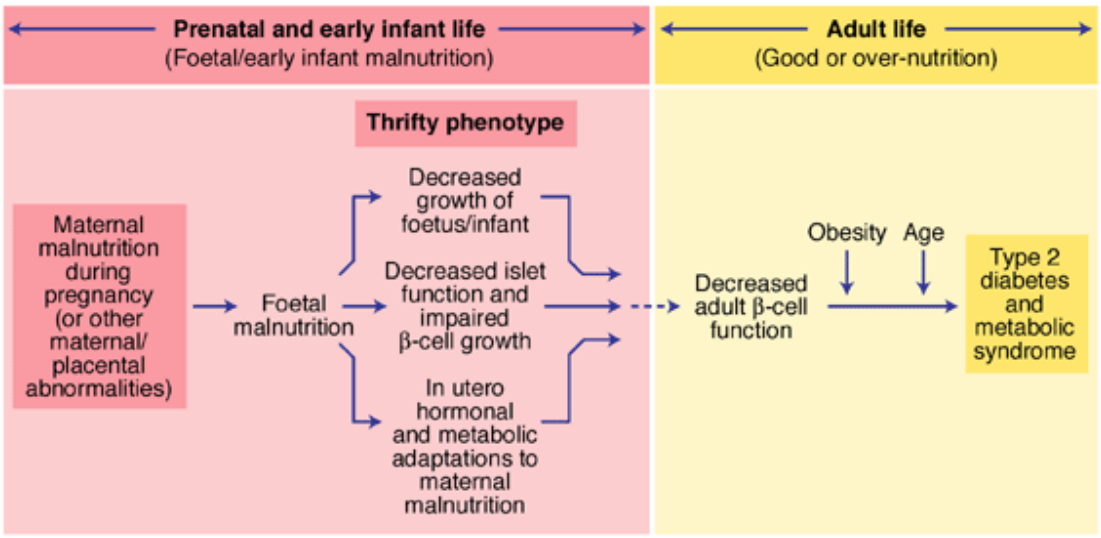
DIET & PHYSICAL ACTIVITY:

The major effects of diet & levels of physical activity on prevalence of MS are probably mediated through their effects on fat distribution & obesity. There is also some evidence to suggest that diet & physical activity also may have an effect on insulin resistance and MS that is independent of obesity. In the Framingham Offspring study, whole

grain intake (mainly from cereal fibre) was associated with a lower prevalence of MS after adjustment for confounding risk factors (McKeown et al.,2004).

BIRTHWEIGHT:

Several studies have suggested that LBW is associated with higher prevalence of MS in adult life. There is growing evidence that the early environment may play a role in mediating the relationship between poor early growth & subsequent risk of disease. This suggestion forms the basis of the 'thrifty phenotype hypothesis' proposed by Hales & Barker in 1992.



Diagrammatic representation of the 'thrifty phenotype' hypothesis of type 2 diabetes

GENETIC FACTORS:

A study of twins in Denmark suggested that environmental factors were more important for WHR, fasting insulin & TGL whereas genetic influences were most marked on glucose intolerance, overall obesity & low HDL.

ENDOCRINE FACTORS:

Endocrine disturbances can influence the prevalence of metabolic syndrome, specifically hyperandrogenemia & polycystic ovary syndrome. Similarities between Cushing's disease and MS also suggest a role for the glucocorticoid axis in the development of MS.

INFLAMMATION:

There is increasing evidence to suggest that chronic subclinical inflammation is associated with insulin resistance & MS.

CONSEQUENCES OF MS

MS is associated with increased risk of a vriety of disease outcomes including

- Diabetes
- Peripheral arterial disease
- Fatty liver & NASH
- Polycystic ovary syndrome
- Gallstones
- Asthma
- Sleep apnea
- Selected malignant diseases (colon, breast)

TREATMENT

MS represents a high risk group for coronary artery disease as well as for type 2 DM. Treatment so far is directed mainly to individualised needs of single traits such as hypertension,dyslipidemia & type 2 DM. Insulin resistance & visceral obesity are major components of the common soil for MS & atherosclerotic vascular disease, therefore lifestyle intervention with reduction of overweight, a low fat diet rich in complex carbohydrates and physical endurance exercise are the primary options that form the basic treatment for all diseases of the metabolic syndrome. It is estimated that more than 50% of the diseases of MS may be treated by intensified lifestyle and behavior modification only. The Ornish program is an example of successful lifestyle intervention.

TREATMENT OPTIONS:

- Treat underlying causes (overweight/obesity and physical inactivity):
    - Intensify weight management
    - Increase physical activity
- Treat lipid and non-lipid risk factors if they persist despite these lifestyle therapies:
    - Treat hypertension
    - Use aspirin for CHD patients to reduce prothrombotic state
    - Treat elevated triglycerides and/or low HDL

HYPERTENSION

Blood pressure is the lateral pressure exerted by the blood on the vessel walls while flowing through it.

Lateral pressure is that pressure when force is exerted at right angles to the direction of flow at any point within a tube filled with a circulating fluid. Resistance is opposite to force.

Systolic pressure : The maximum pressure during systole.

Diastolic pressure : The minimum pressure during diastole.

Pulse pressure : The difference between systolic and accepted diastolic pressure

Mean pressure : Diastolic pressure plus one third of pulse pressure

PHYSIOLOGY

PHYSIOLOGICAL VARIATIONS IN BP:

A. AGE

Blood pressure rises with age. During infancy the systolic pressure is from 70 – 90 mm Hg. In children it is 90 – 110 mmHg and at puberty 110- 120 mm Hg.

B. SEX

In females both systolic and diastolic pressures are slightly lower than in males up to the age of 40 – 50 years.

C. BUILD

The systolic pressure is usually high in obese persons

D. EXERCISE

In strenuous exercise the systolic pressure increases and may reach even up to 180 mm Hg and in moderate exercise there is a slight increase in systolic pressure.

E. POSTURE

The diastolic pressure is slightly higher in the standing position. In the recumbent posture the diastolic pressure is lower than in standing or sitting posture.

F. SLEEP

Systolic pressure falls by about 15 – 20 mmHg during sleep.

G. AFTER INGESTION OF FOOD

There is a slight increase of systolic pressure

H. EMOTION OR EXCITEMENT

Causes increase in systolic pressure

FACTORS CONTROLLING ARTERIAL BLOOD PRESSURE

1. Pumping action of the heart

2. Cardiac output
3. Peripheral vascular resistance: It is the resistance which the blood has to overcome while passing through the periphery. The chief seat of arterial resistance is the arterioles. It depends upon the following

    a. Velocity of blood
    b. Elasticity of arterial walls
    c. Lumen of blood vessels

4. Elasticity of arterial walls
5. Blood volume
6. Viscosity of blood

SIGNIFICANCE OF BLOOD PRESSURE

The height of systolic pressure indicates:

1. The extent of work done by the heart
2. The force of pumping
3. The degree of pressure the arterial walls have to withstand.

Diastolic pressure indicates the measure of peripheral vascular resistance against which the heart has to work constantly.

The normal function of blood pressure is

1. To maintain sufficient pressure head to keep the blood flowing.
2. To provide for the motive force of filtration at the capillary bed thus providing nutrition to the tissue, formation of lymph and so on.

MEASUREMENT OF BLOOD PRESSURE
GENERAL PRECAUTIONS

Errors in measurement revolve around the patient, the instrument, the technique of measurement and the examiner.

THE PATIENT

The level of arterial blood pressure both systolic and diastolic may vary considerably with the phase of respiration or with the changes in cardiovascular hemodynamics. Deep breathing, crying, laughing, anxiety, recent activity and abnormal body temp may exert profound influences. Thus it is important to reassure the patient and to allow time for recovery from apprehension or recent activity. Since the state of relaxation is generally less stable in children than in adults, greater difference with consecutive measurements are often observed particularly with age group under 2 to 4 yrs.

THE CHOICE OF INSTRUMENT

The mercury manometer is the sphygmomanometer of choice as it has the advantages of widespread general usage, reliability, accuracy and of not requiring recalibration. The level of mercury at zero cuff pressure and definition of the meniscus should be checked before measurement. Aneroid manometers are inferior to the mercury type since the former are more sensitive to jolt and mechanical error.

TECHNIQUE OF MEASUREMENT

The mercury column must be vertical and the eyes of the examiner should be at the level of meniscus. The appropriate sized cuff should be used.

The preparation of the child is essential for the determination of BP. The examining room should be quiet. The procedure is fully explained to the children and they are allowed to sit for 15 minutes to recover from recent activity and apprehension. The children were examined in a comfortable sitting position with right arm fully exposed, resting on a supportive surface at the heart level. The manometer should be placed at the observer eye level.

THE WIDTH OF THE CUFF

The Riva Rocci's cuff which is too narrow may result in an error on the higher side whereas one which is too wide may result in an error on the lower side. Use of a narrow cuff requires higher inflation pressures to compress the artery while the use of a cuff which is too wide compresses a large segment of the vessel, resulting in increased resistance to flow and a tendency for pulse to disappear before it reaches the lower edge of the cuff.

Although Moss et al., established a relatively precise index for proper cuff selection for a given child, for practical purposes it is significant merely to select a cuff which covers about two thirds of the arm length.

DIMENSIONS FOR APPROPRIATE SIZE CUFF

Range of dimension of the bladder (in cm)

Cuff name	Width (cm)	Length (cm)
Newborn	2.5- 4	5 – 10
Infant	6 - 8	12 -1 3
Child	9 - 10	17 – 22.5
Adult	12 - 13	22 – 23.5
Large adult arm	15.5	30
Adult thigh	18	36

LENGTH OF THE CUFF

Ideal cuff should have a bladder length that is 80% and a width that is at least 40% of the arm circumference.(Length to width ratio of 2:1 Pickering et al).

Data regarding the appropriate size cuff for measurement of blood pressure in the lower extremity is lacking. The common impression that arterial pressure is higher in the leg than in the arm is a misconception and probably reflects the use of cuffs with inadequate width.

The cuff should be applied snugly to the bare limb. A loosely applied cuff results in ballooning of the bag and narrowing of the effective surface.

THE EXAMINER

Determination of the blood pressure can be entrusted to physician's ability to hear the Korotkoff sounds and relate them to calibrated mercury column. It is recommended that the average of at least three readings of systolic and diastolic pressures be accepted as the final estimate.

METHODS OF BLOOD PRESSURE MEASUREMENT
AUSCULTATORY METHOD

The diaphragm of the stethoscope is firmly applied over the cubital fossa. It should not be in contact with the lower edge of the cuff. The cuff should be inflated rapidly by about 30 mm of mercury above the systolic BP detected by palpatory method and the cuff be deflated at 2 mm Hg per second. Too rapid deflation rate can result in error in either direction. Low value obtained when the rate is so fast that the various phases of vascular sounds cannot be accurately interpreted. High values are obtained if the rapid rate of deflation creates a negative pressure above the mercury column and prevents the equalization of the pressure in the cuff and the manometer. Inflation must be rapid since slow inflation may result I a period between systolic and diastolic pressure during which all vascular sounds disappear (auscultatory gap). The auscultatory gap may result in profound error in interpretation of either systolic or diastolic pressure.

With cuff inflation above the peak pressure of the arterial pulse wave, the artery is completely occluded. With gradual deflation, the vessel opens and the pressure pulse is transmitted to the periphery and the vascular sounds of Korotkoff become audible. These can be identified as occurring in 5 distinct phases

Phase 1: A sudden appearance of a sharp thud

Phase 2: Prolongation of sound into a murmur

Phase 3: Increased intensity of sound

Phase 4: Muffling of sounds

Phase 5: Complete disappearance of sounds

There is a universal agreement that phase 1 is the index of systolic BP. The index of diastolic BP is less certain and rests between muffling and cessation of the sounds.

Available data indicate that in children, muffling is probably the best index but neither muffling nor cessation accurately reflect intra arterial pressure.

Muffling tends to give higher readings and cessation gives lower reading. Latest recommendations of the American Heart Association regards muffling as the best index of diastolic BP.

Some attention should be directed to the measurement of BP in school going children. It is particularly here that proper selection of cuff size is crucial. It is important to recognize that although some of the cuff pressure may be dissipated by excessive fatty tissue. In view of higher incidence of hypertension in these subjects, it would be a mistake to dismiss on abnormally high readings on the basis of error due to cuff size.

OTHER METHODS OF INDIRECT MEASUREMENT

In infants, measurement of BP by auscultation is often difficult or impossible and other methods must be used. A wide variety of mechanical and electronic devices have been used nowadays but all are based on the traditional methods of palpation, auscultation or oscillometry. Infant should be quiet and immobile since movement or crying will profoundly affect the reading obtained.

ULTRASOUND

Ware et al., described the indirect measurement of systolic pressure utilizing the Doppler principle. This method has been proved quite reliable and a number of devices are commercially available . Antonio Hernandez et al.

FLUSH METHOD

In 1952, Cappe et al., and Goldring et al measured the digital BP by application of a pneumatic cuff to the wrist.

With the infant in a recumbent position, the arm and ankle cuffs are applied. The extremity distal to the cuff is compressed by firmly wrapping it with a soft wide rubber drain, an elastic bandage the purpose of which is to drain the hand or foot of the blood. The wrapping should begin at the tips of the digits working proximally to the lower edge of the

cuff. Compression with one hand is to be condemned since it often produces inaccurate results because of incomplete drainage leading to poor definition of the end point. A 5 cm cuff is generally easier to work with but it has been established that various cuffs from 5 – 9.5 cm in width does not significantly affect the reading.

Following completion of the compression, the cuff is inflated to 200 mm Hg and the wrapping removed with slow release of cuff pressure, a level is eventually reached at which there is a definite flushing of the blanched distal portion of the extremity. This is the end point with a deflation rate not exceeding 5 mmHg /second. The end point has been found to approximate the mean arterial pressure.

Viring et al., recognized that severe anemia, edema and marker hypothermia may adversely affect the end point. Although there are conflicting opinions, it appears that the flush BP is greater in the wrist than ankle during the first yr of life.

PALPATORY METHOD

This is the oldest one, seldom used alone. The radial pulse is located and the pressure in the pneumatic cuff is raised above the level at which palpable pulsation disappears. With gradual deflation of the cuff, the pulsation reappears. The first palpable sound is considered as the systolic BP. This is usually 5 – 10 mm lower than auscultatory method.

VISUAL OSCILLOMETRY

This method was first introduced in 1904 and is based on visualization of the oscillations transmitted by the arterial pulse to the mercury column in the manometer. With cuff deflation, the level at which the oscillation appears and disappears is read as the systolic and diastolic BP respectively. Nowadays this method is not in use.

AIM OF THE STUDY

1. To assess the prevalence of
    - Overweight and
    - Hypertension

   in adolescent school children.

2. To assess the association of factors like
    - Sex
    - Socioeconomic status
    - Family H/O obesity
    - Family H/O HT/DM and
    - Hours of physical activity

   with overweight in these children

MATERIALS AND METHODS

STUDY DESIGN :

Cross sectional survey/ Case control study

PLACE OF STUDY :

Govt. middle schools, high schools and higher secondary schools & private schools in Chengalput

INCLUSION :

Healthy boys and girls 13 – 17 years

CRITERIA

EXCLUSION CRITERIA

Obesity due to endocrine abnormalities

Syndrome associations

Secondary hypertension

Cardiac / Renal disease

Chronic drug intake

SAMPLE SIZE:

For an existing prevalence of 10%, with 20% precision accuracy and 95% confidence interval, sample size calculated by formula is 1060

$$n = 1060$$

CASES :

Children "at risk of overweight" and "overweight"

BMI 85th to 94th percentile - "at risk of overweight"

BMI >95th percentile - "overweight"

All children above 85th percentile will be arbitrarily taken as overweight for this study purpose.

Blood pressure >95th percentile - "hypertension"

CONTROLS : Normal children

RISK FACTORS:

1. **SEX**

2. **SOCIOECONOMIC STATUS**

The modified Kuppusamy Scale (1997-1998) was used which takes into consideration education and occupation of the parent and the monthly per capita income. Children with a score of fifteen and above were arbitrarily assigned to the high socioeconomic status and those with score <15 were put in the low socioeconomic group

3. **FAMILY H/O HT/DM**

4. **FAMILY H/O OBESITY**

5. PHYSICAL ACTIVITY

Arbitarily those children with a physical activity of < 30 minutes for 4 days/week were taken to be at a higher risk.

METHODOLOGY:

The subjects of the study were adolescent school children between the ages of 13 – 17 years of both sexes and belonging to high and low socioeconomic classes as per the modified Kuppusamy's scale.

Age was taken in completed years from the school records.

Height was taken using a vertical scale to the nearest 0.5 cm.

Weight was measured using a standard weighing scale to the nearest 0.5 kg.

The procedure was informed to all children and measures had been taken to reduce their anxiety. Their cooperation was sought specifically for information regarding their father's education, occupation, monthly income, no of family members, family H/O obesity, HT/DM, hours of physical activity, details of any previous illness or chronic drug intake.

RECORDING OF BLOOD PRESSURE

A cordial atmosphere was created to do an unhurried and relaxed examination. A cursory physical examination was done to rule out endocrine, cardiac and renal problems. BP recording was done as the last part of the examination to allay the anxiety of the child. Prior to recording the child was asked to void urine and basal pressures were obtained. The basal pressure in adolescents seems to be a better predictor of essential hypertension in adulthood than casual blood pressure.

The instrument used was mercury sphygmomanometer in conjunction with a good stethoscope for all ages. Cuff sizes of 7 cm and 12 cm were used and care was taken to select an appropriate sized cuff which covered two third of the arm. All observations were made in the right arm with the child properly seated and the sphygmomanometer at the child's heart level. The cuff was firmly placed over the brachial artery and inflated to 30 mm Hg above the systolic BP calculated by the palpatory method. Then the cuff was deflated by 2 – 4 mm per second. The appearance of the first Korotkoff sound and muffling were taken as corresponding to systolic and diastolic blood pressures respectively. Three readings taken at an interval of 5 minutes each and average of the three readings was taken as the blood pressure.

STATISTICAL ANALYSIS

To examine the various determinants of overweight & obesity like sex, socioeconomic status, family H/O obesity, family H/O HT & DM and physical activity, univariate and multivariate analysis (logistic regression) were performed.

The unadjusted & adjusted odds ratios were computed for overweight with other risk factors collected in the study.

All analysis were two tailed and a p value of <0.05 was considered statistically significant. Statistical analysis was performed using SPSS version 10.0 package.

OBSERVATIONS

TABLE 1

SEX DISTRIBUTION

Sex	No of children	Percentage
Male	510	48%
Female	550	52%
Total	1060	100%

FIGURE 1

SEX DISTRIBUTION

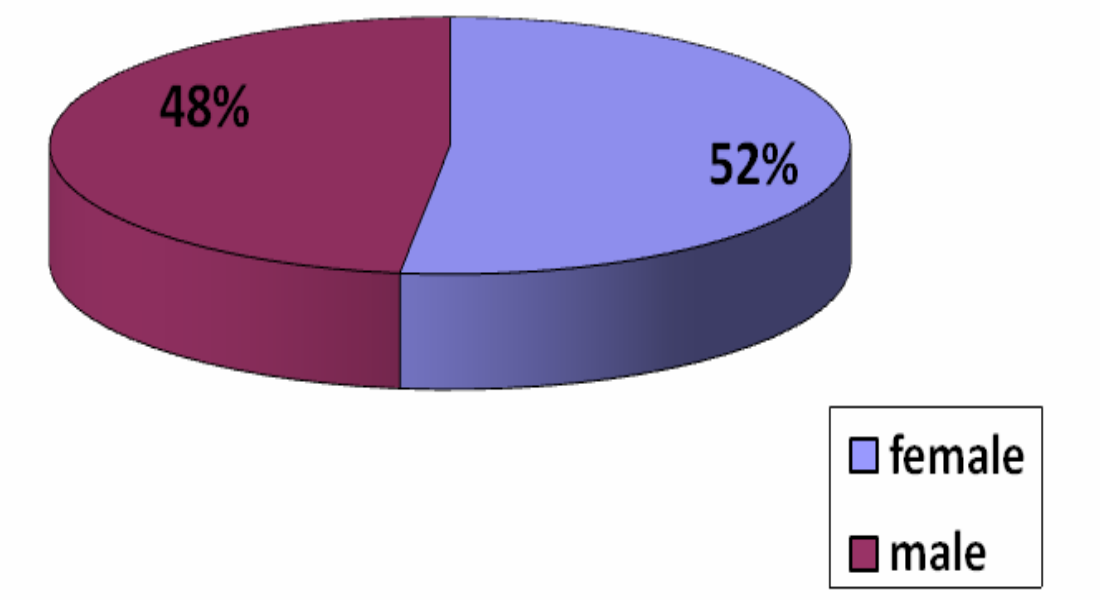


TABLE 2

AGE & SEX DISTRIBUTION

Age	Male	Female	Total	Percentage
13	48	67	115	10.8%
14	67	123	190	17.9%
15	128	156	284	26.8%
16	164	149	313	29.6%
17	103	55	158	14.9%
Total	510	550	1060	100%

Highest number of cases studied was in the age group 16 yrs. In the other groups an average of 150 cases were studied.

TABLE 3

MEAN AND PERCENTILE POSITION FOR SYSTOLIC BP BASED ON AGE AND SEX

Age (yrs)	MALE				FEMALE			
	n	Mean ± SD	5th	95th	n	Mean ± SD	5th	95th
13	48	112.58 ± 9.91	97.8	125.2	67	107.61±10.45	94.0	120.8
14	67	113.58 ± 9.73	100	126.4	123	109.06±11.11	92.4	124.0
15	128	113.48 ± 9.78	97.8	128.2	156	112.29±11.38	94.0	124.6
16	164	114.04±11.38	96.0	129.0	149	111.91±11.99	90	128.0
17	103	115.17±11.64	96	130.0	55	114.07±12.52	90	129.0

TABLE 4

MEAN AND PERCENTILE POSITION FOR DIASTOLIC BP BASED ON AGE AND SEX

Age (yrs)	MALE				FEMALE			
	n	Mean ±SD	5th	95th	n	Mean ±SD	5th	95th
13	48	74.25±5.11	67	78.2	67	69.85±8.64	64.0	76.2
14	67	73.46±6.44	68.2	79.6	123	72.23±7.76	66.0	78.4
15	128	74.84±5.72	70.6	80.4	156	73.96±7.33	64.3	79.6
16	164	74.49±6.14	71.2	81.3	149	74.03±7.49	65.6	80.0
17	103	75.05±6.16	72.6	83.8	55	76.51±6.31	70.2	82.8

TABLE 5

TYPE OF HYPERTENSION IN VARIOUS AGE GROUPS

	13 yrs		14 yrs		15 yrs		16 yrs		17 yrs	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Normal BP	40	51	60	104	112	127	139	124	88	50
Systolic HT	6	3	5	5	8	10	11	8	6	2
Diastolic HT	0	1	0	0	1	0	0	2	0	0
Both	0	2	1	5	2	3	5	3	2	1
Low BP	2	10	1	9	5	16	9	12	7	2
Chisquare value	7.735 NS		4.782 NS		5.418 NS		3.547 NS		1.094 NS	

FIGURE 2

TYPE OF HYPERTENSION IN VARIOUS AGE GROUPS

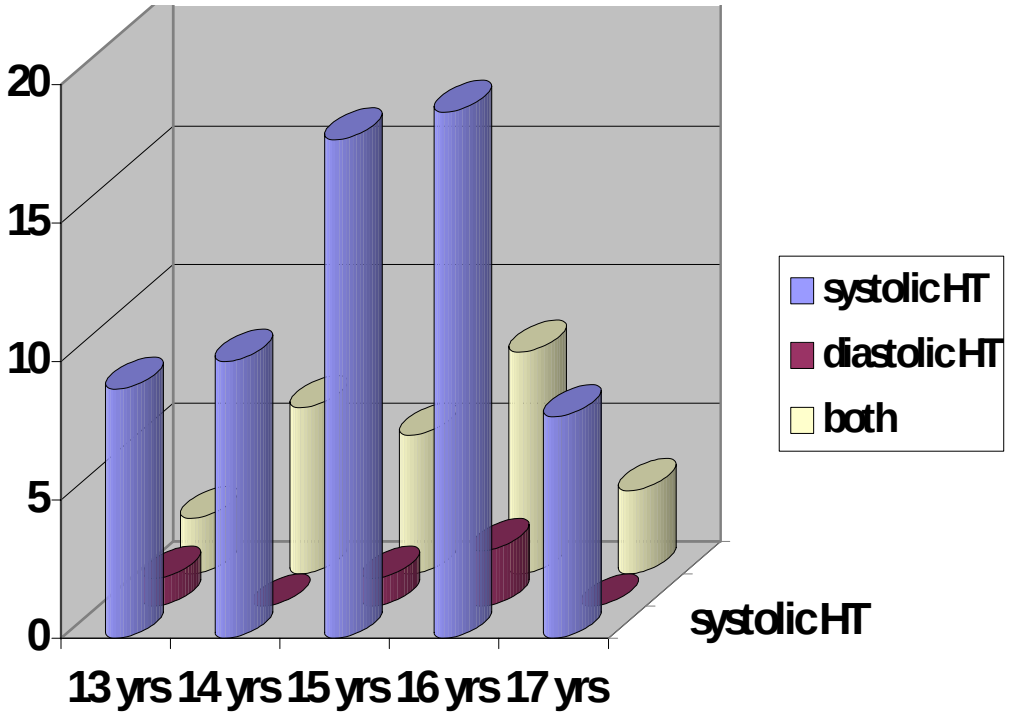


TABLE 6

AGE RELATED HYPERTENSION

Age	Male			Female		
	Total	**HT**	**%**	**Total**	**HT**	**%**
13	48	6	12.5%	67	6	8.95%
14	67	6	8.95%	123	10	8.13%
15	128	11	8.59%	156	13	8.33%
16	164	16	9.75%	149	13	8.72%
17	103	8	7.76%	55	3	5.45%

FIGURE 3

PREVALENCE OF HYPERTENSION IN VARIOUS AGE GROUPS

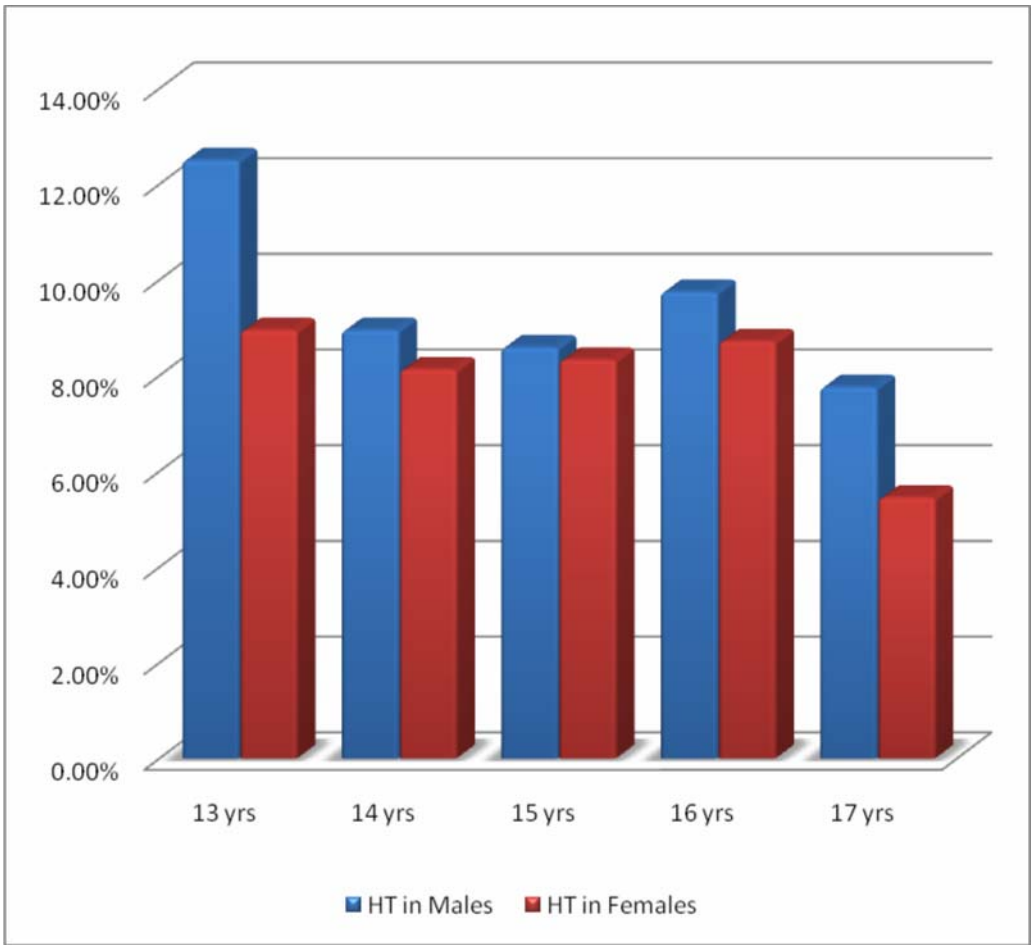


TABLE 7

PREVALENCE OF HYPERTENSION

Number of children studied	Number of children with hypertension	Percentage
1060	92	8.67%

FIGURE 4

PREVALENCE OF HYPERTENSION

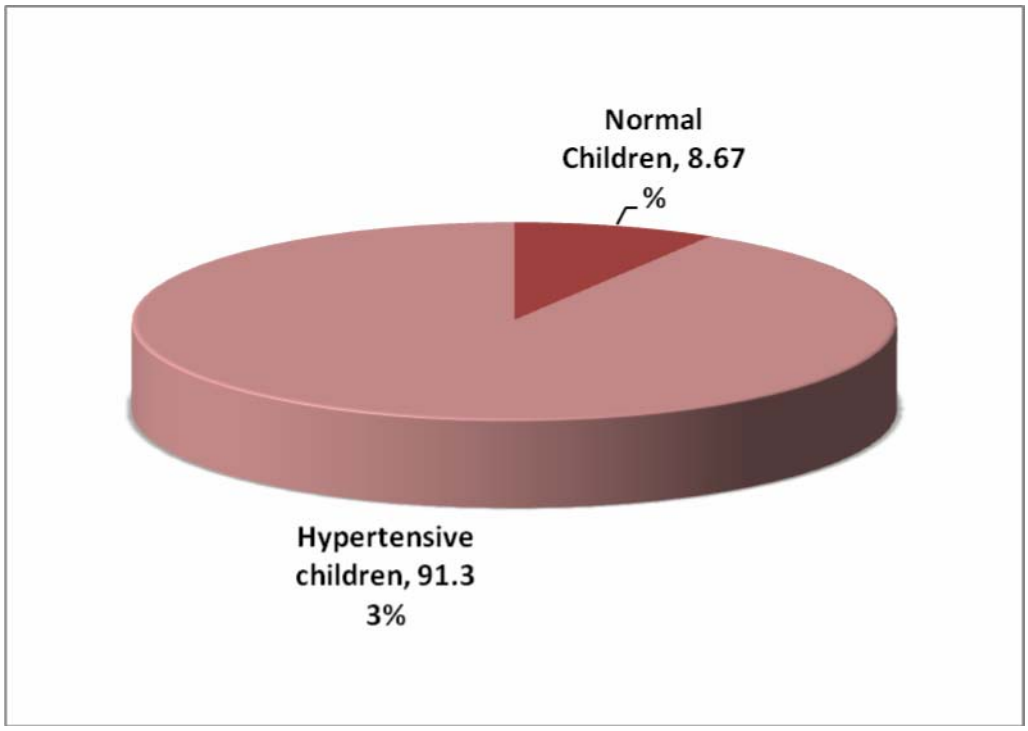


TABLE 8

PREVALENCE OF OVERWEIGHT AMONG MALES

Age	Total population	Overweight (BMI>85th percentile)	Percentage
13	48	4	8.4%
14	67	7	10%
15	128	13	9.9%
16	164	12	7.6%
17	103	9	8.9%
Total	**510**	**45**	**8.82%**

FIGURE 5

PREVALENCE OF OVER WEIGHT AMONG MALES

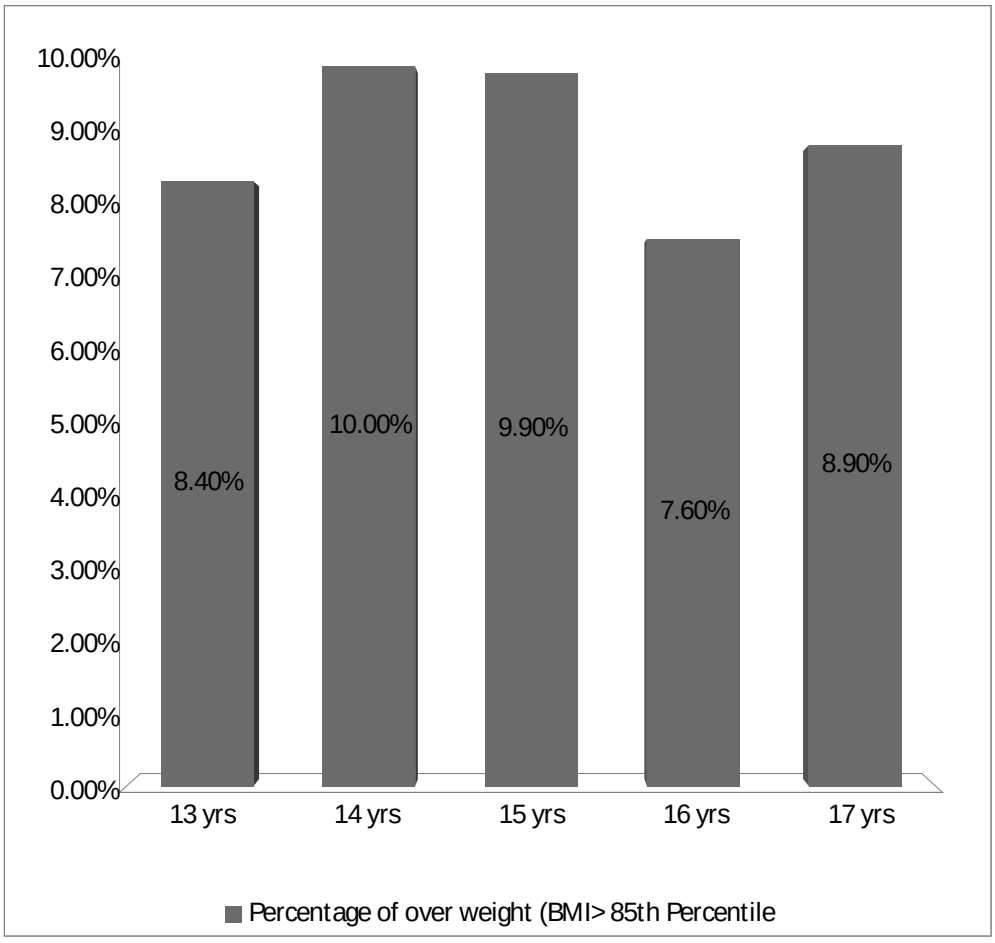


TABLE 9

PREVALENCE OF OVERWEIGHT AMONG FEMALES

Age	Total population	Overweight (BMI>85th percentile)	Percentage
13	67	8	11.9%
14	123	16	13.4%
15	156	19	12.08%
16	149	16	10.57%
17	55	7	13.07%
Total	**550**	**66**	**12%**

FIGURE 6

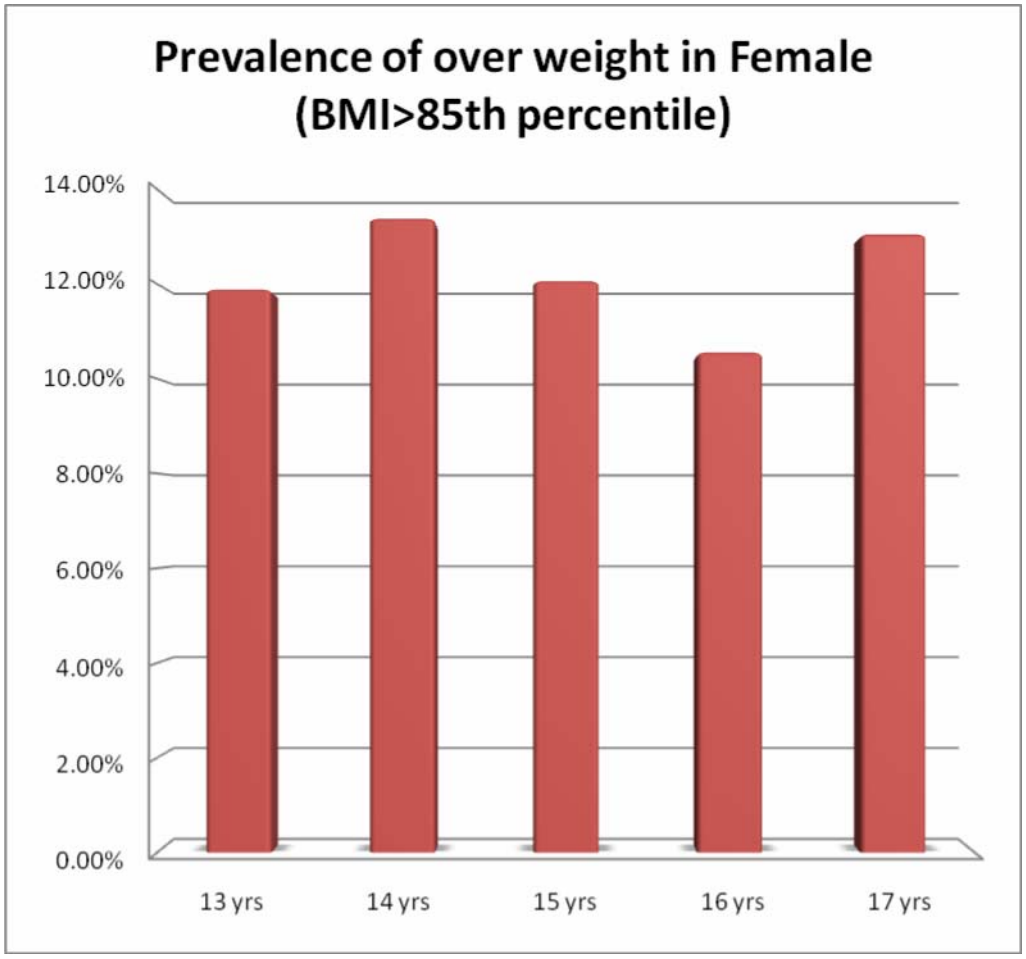

Prevalence of over weight in Female
(BMI>85th percentile)
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
13 yrs
14 yrs
15 yrs
16 yrs
17 yrs

FIGURE 7

PREVALENCE OF OVERWEIGHT AMONG BOYS

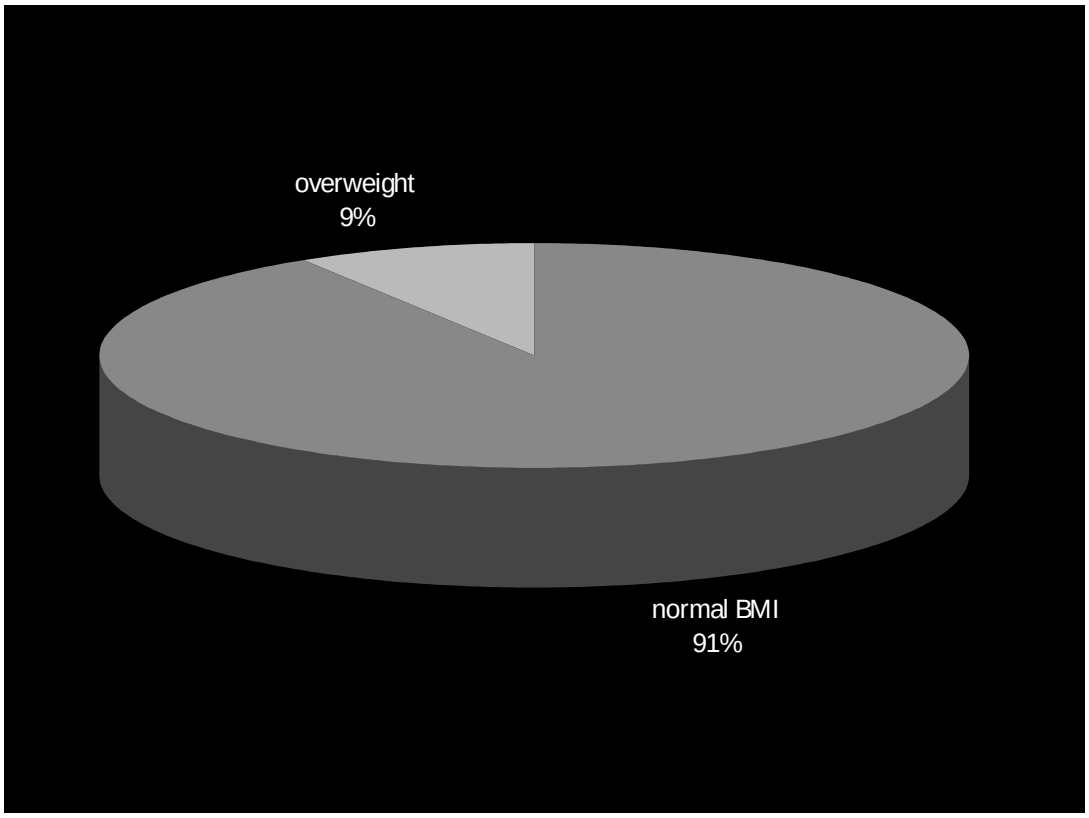
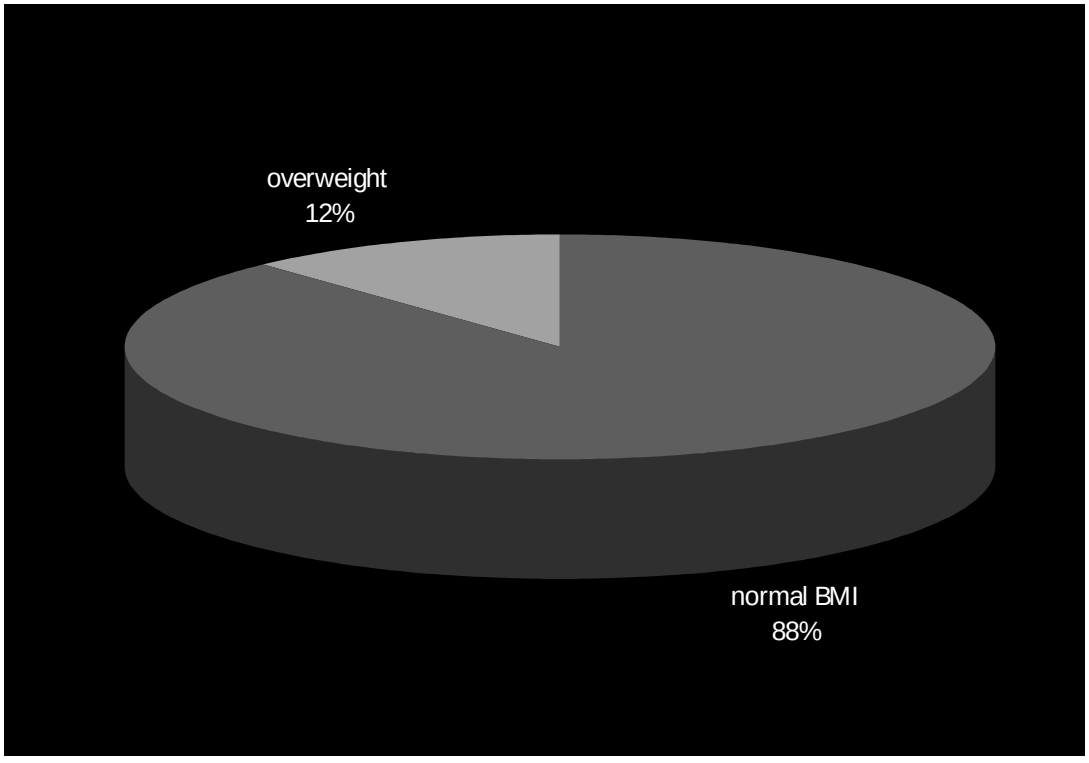


FIGURE 8

PREVALENCE OF OVERWEIGHT AMONG FEMALES



RISK FACTORS FOR OVERWEIGHT AMONG 13 – 17 YR OLDS – A UNIVARIATE ANALYSIS

S. No	Risk factor		Cases		Control		OR (95% CI)	p value
			n	%	n	%		
1.	**Sex**	Female	66	12%	484	88%	1.388 (1.115-1.727)	0.004
		Male	45	8.82%	465	91.18%		
2.	**Socio economic status**	High	102	17.1%	499	82.9%	2.062 (1.409-3.017)	0.000
		Low	42	9.1%	417	90.7%		
3.	**Family H/O HT/DM**	Yes	13	14.2%	81	85.8%	1.665 (1.205-2.301)	0.000
		No	87	9.0%	879	91%		
4.	**Family H/O obesity**	Yes	37	29.2%	89	80.8%	4.206 (2.728-6.486)	0.000
		No	83	8.9%	851	91.1%		
5.	**Physical activity**	<30 min	31	9.8%	289	90.2%	0.959 (0.761-1.209)	0.770
		>30 min	69	9.4%	671	90.6%		

TABLE 11

RISK FACTORS FOR OVERWEIGHT IN CHILDREN 13 – 17 YRS – A MULTIVARIATE ANALYSIS

Risk factor	SE	df	Significance	OR	95% CI	
					Lower	Upper
Family H/O HT/DM	0.170	1	0.002	1.677	1.203	2.339
Family H/O obesity	0.225	1	0.000	4.679	3.089	7.276
High socioeconomic status	0.119	1	0.000	2.179	1.475	3.220
Female sex	0.115	1	0.057	1.246	0.994	1.562

DISCUSSION

A total of 1060 cases in age groups 13 – 17 yrs of age was tabulated. The highest no of case were studied in the age group of 16 yrs and lowest number in the age group of 13 yrs.

The mean systolic & diastolic BP levels of the 1060 children were studied in relation to age in both sexes. BP levels were found to increase progressively with age.

The gradual increase in mean systolic & diastolic BP of boys & girls with age as noted by us agrees with the findings of The Task Force Committee Report and other workers. Dubest Londe et al.,

The mean systolic pressure of males for various age groups are higher than females. The difference in diastolic pressure between males and females is negligible.

In Indian school children an increase in systolic BP & diastolic BP with age has also been reported by various authors – Chahar et al., Verma et al., Anand & Tandon, Chadha et al.,

In the present study, the value of systolic & diastolic BP is slightly lower among girls than boys but the difference was not found to be statistically significant in most of the age groups. This is consistent with the finding of Laroia et al., Voors et al, Anand & Tandon et al., Chadha et al.

The prevalence of HT in school children of Chengalput is 9.21% in boys & 8.18% in girls in our study. According to Chadha et al., the prevalence of HT in Delhi school children of age 5 – 14 yrs is 11.7%. Anjana, Prabhjot et al., reported a prevalence of 7.5% in boys & 6.52% in girls in Amritsar. But Chahar et al., Agarwal et al & Anand & Tandon reported a low prevalence of hypertension i.e. o.41 – 3.5% among school children. The reason for low prevalence of hypertension in this population according to Chadha is mainly due to the use of arbitrary criterion of HT assessment & not the recognized criterion of 95^{th} percentile for age & sex.

In the present sample, sex difference in the prevalence of HT was not statistically significant (p value> o.o5). The finding that there are no appreciable sex difference in the prevalence of HT among school children has also been observed by Chadha,Anand & Tandon, Voors et al.,

In our study, the prevalence of overweight is 10.47%(111/1060). Overweight among males was 8.82% (45/510) and among females was 12% (66/550).

Prevalence of overweight among low socioeconomic status was 9.1% compared to 17.1% among high socioeconomic status in our study.

Family H/O HT/DM among overweight children was 13% compared to 8.4% in others.

Overweight children were 4 times more likely to have a family H/O of obesity compared to children with normal BMI [OR(95% CI) 4.20(2.728-6.486)].

Overweight children were 1.3 times more likely to be females when compared to children with normal BMI [OR (95% CI) 1.388 (1.115- 1.727)].

Physical activity was not found to be a significant risk factor by univariate analysis by our study.

The factors which were found to be significant by univariate analysis namely family H/O HT/DM, family H/O obesity, high socioeconomic status and female sex were included for multivariate analysis.

Three risk factors namely

Family H/O HT/DM [OR (95% CI) 1.677 (1.203 – 2.339)] &

Family H/O obesity [OR (95%CI) 4.679(3.009- 7.276)] &

High socioeconomic status [OR (95% CI) 2.179 (1.475 – 3.220)] were found to be independent risk factors for overweight by multivariate analysis in the study.

SUMMARY

- The prevalence of HT (BP> 95th percentile) in adolescent children 13 – 17 yrs was found to be 9.21 % in boys and 8.18% in girls.
- BP levels were found to increase progressively with age.
- "At risk for overweight" and "overweight" (BMI >85th percentile) had an overall prevalence of 10.47% (8.82% in males and 12% in females).
- High socio economic status, family H/o obesity and family H/O HT/DM were found to be independent risk factors for overweight in the children studied.

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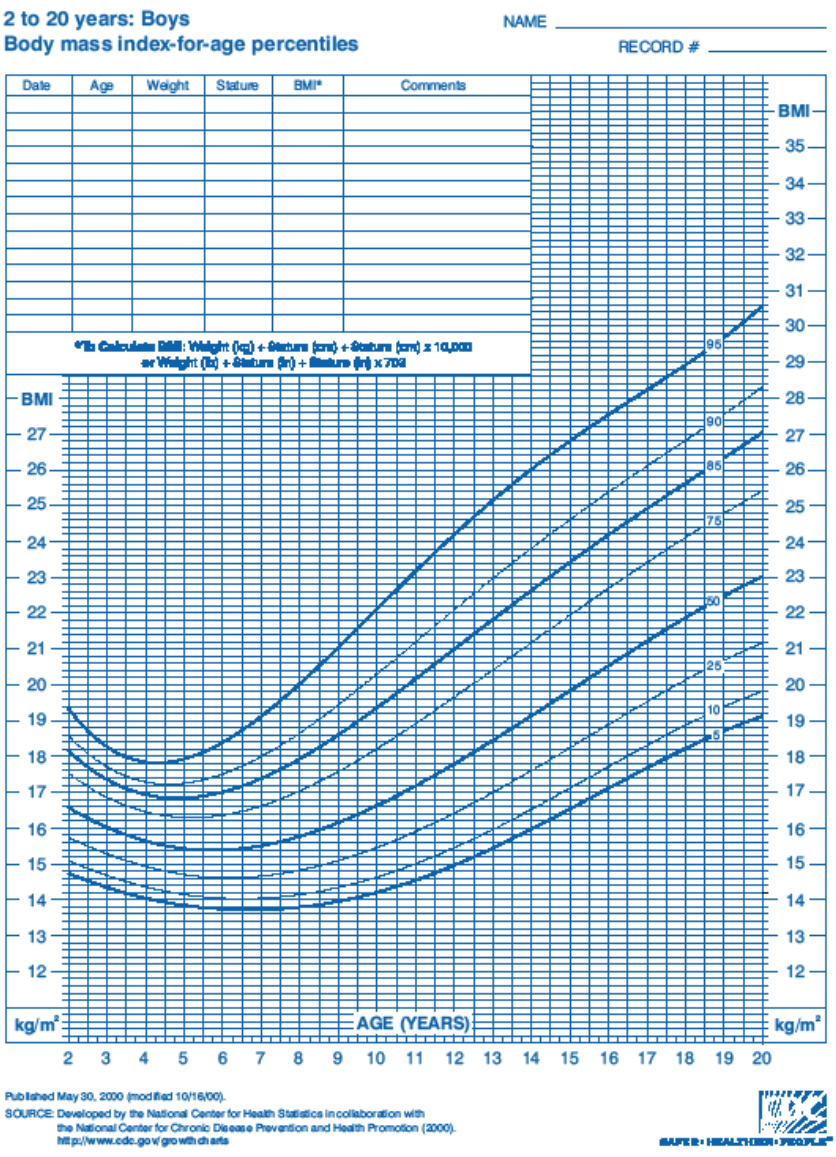
ANNEXURE 1

PROFORMA

1. Name
2. Age
3. Sex
4. School
5. Father’s education
6. Father’s occupation
7. Father’s monthly income
8. No of family members
9. Socio economic class (Modified Kuppusamy scale)
10. Height (cm)
11. Weight (kg)
12. BMI BMI percentile
13. Physical activity > 30 min for 4 days /wk Yes or No:
14. Family H/o obesity
15. Family H/o HT/DM
16. Pallor / edema/ skin infection/previous illness/chronic drug intake
17. Pulse rate /volume
18. BP 1. 2. 3.
19. Mean BP

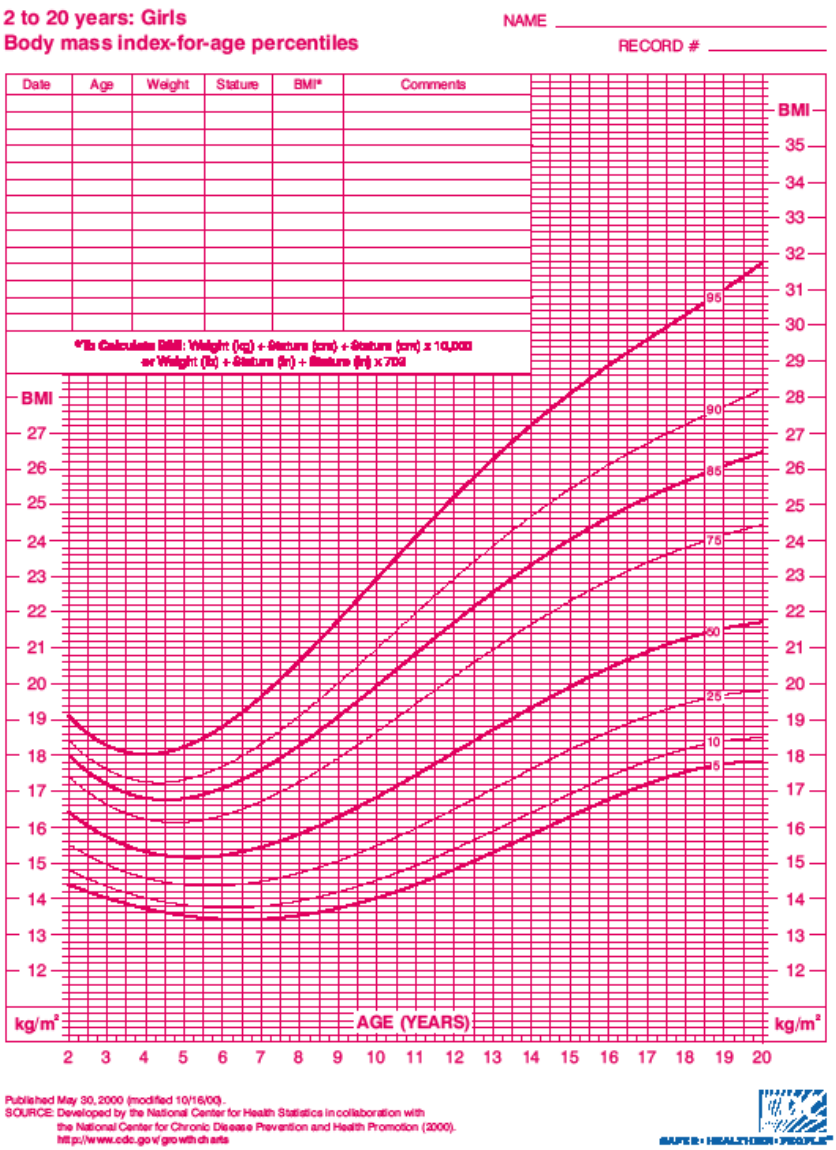
ANNEXURE 2



Published May 30, 2000 (modified 10/16/00).

SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000). http://www.cdc.gov/growthcharts

ANNEXURE 3


2 to 20 years: Girls
Body mass index-for-age percentiles
NAME
RECORD #
Date
Age
Weight
Stature
BMI*
Comments
*To Calculate BMI: Weight (kg) ÷ Stature (cm) ÷ Stature (cm) x 10,000
or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703
BMI
kg/m²
AGE (YEARS)
95
90
85
75
50
25
10
5
Published May 30, 2000 (modified 10/16/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with
the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts

Blood Pressure Levels for Boys by Age and Height Percentile

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	80	81	83	85	87	88	89	34	35	36	37	38	39	39
	90th	94	95	97	99	100	102	103	49	50	51	52	53	53	54
	95th	98	99	101	103	104	106	106	54	54	55	56	57	58	58
	99th	105	106	108	110	112	113	114	61	62	63	64	65	66	66
2	50th	84	85	87	88	90	92	92	39	40	41	42	43	44	44
	90th	97	99	100	102	104	105	106	54	55	56	57	58	58	59
	95th	101	102	104	106	108	109	110	59	59	60	61	62	63	63
	99th	109	110	111	113	115	117	117	66	67	68	69	70	71	71
3	50th	86	87	89	91	93	94	95	44	44	45	46	47	48	48
	90th	100	101	103	105	107	108	109	59	59	60	61	62	63	63
	95th	104	105	107	109	110	112	113	63	63	64	65	66	67	67
	99th	111	112	114	116	118	119	120	71	71	72	73	74	75	75
4	50th	88	89	91	93	95	96	97	47	48	49	50	51	51	52
	90th	102	103	105	107	109	110	111	62	63	64	65	66	66	67
	95th	106	107	109	111	112	114	115	66	67	68	69	70	71	71
	99th	113	114	116	118	120	121	122	74	75	76	77	78	78	79
5	50th	90	91	93	95	96	98	98	50	51	52	53	54	55	55
	90th	104	105	106	108	110	111	112	65	66	67	68	69	69	70
	95th	108	109	110	112	114	115	116	69	70	71	72	73	74	74
	99th	115	116	118	120	121	123	123	77	78	79	80	81	81	82
6	50th	91	92	94	96	98	99	100	53	53	54	55	56	57	57
	90th	105	106	108	110	111	113	113	68	68	69	70	71	72	72
	95th	109	110	112	114	115	117	117	72	72	73	74	75	76	76
	99th	116	117	119	121	123	124	125	80	80	81	82	83	84	84
7	50th	92	94	95	97	99	100	101	55	55	56	57	58	59	59
	90th	106	107	109	111	113	114	115	70	70	71	72	73	74	74
	95th	110	111	113	115	117	118	119	74	74	75	76	77	78	78
	99th	117	118	120	122	124	125	126	82	82	83	84	85	86	86
8	50th	94	95	97	99	100	102	102	56	57	58	59	60	60	61
	90th	107	109	110	112	114	115	116	71	72	72	73	74	75	76
	95th	111	112	114	116	118	119	120	75	76	77	78	79	79	80
	99th	119	120	122	123	125	127	127	83	84	85	86	87	87	88
9	50th	95	96	98	100	102	103	104	57	58	59	60	61	61	62
	90th	109	110	112	114	115	117	118	72	73	74	75	76	76	77
	95th	113	114	116	118	119	121	121	76	77	78	79	80	81	81
	99th	120	121	123	125	127	128	129	84	85	86	87	88	88	89
10	50th	97	98	100	102	103	105	106	58	59	60	61	61	62	63
	90th	111	112	114	115	117	119	119	73	73	74	75	76	77	78
	95th	115	116	117	119	121	122	123	77	78	79	80	81	81	82
	99th	122	123	125	127	128	130	130	85	86	86	88	88	89	90

Blood Pressure Levels for Boys by Age and Height Percentile (Continued)

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
11	50th	99	100	102	104	105	107	107	59	59	60	61	62	63	63
	90th	113	114	115	117	119	120	121	74	74	75	76	77	78	78
	95th	117	118	119	121	123	124	125	78	78	79	80	81	82	82
	99th	124	125	127	129	130	132	132	86	86	87	88	89	90	90
12	50th	101	102	104	106	108	109	110	59	60	61	62	63	63	64
	90th	115	116	118	120	121	123	123	74	75	75	76	77	78	79
	95th	119	120	122	123	125	127	127	78	79	80	81	82	82	83
	99th	126	127	129	131	133	134	135	86	87	88	89	90	90	91
13	50th	104	105	106	108	110	111	112	60	60	61	62	63	64	64
	90th	117	118	120	122	124	125	126	75	75	76	77	78	79	79
	95th	121	122	124	126	128	129	130	79	79	80	81	82	83	83
	99th	128	130	131	133	135	136	137	87	87	88	89	90	91	91
14	50th	106	107	109	111	113	114	115	60	61	62	63	64	65	65
	90th	120	121	123	125	126	128	128	75	76	77	78	79	79	80
	95th	124	125	127	128	130	132	132	80	80	81	82	83	84	84
	99th	131	132	134	136	138	139	140	87	88	89	90	91	92	92
15	50th	109	110	112	113	115	117	117	61	62	63	64	65	66	66
	90th	122	124	125	127	129	130	131	76	77	78	79	80	80	81
	95th	126	127	129	131	133	134	135	81	81	82	83	84	85	85
	99th	134	135	136	138	140	142	142	88	89	90	91	92	93	93
16	50th	111	112	114	116	118	119	120	63	63	64	65	66	67	67
	90th	125	126	128	130	131	133	134	78	78	79	80	81	82	82
	95th	129	130	132	134	135	137	137	82	83	83	84	85	86	87
	99th	136	137	139	141	143	144	145	90	90	91	92	93	94	94
17	50th	114	115	116	118	120	121	122	65	66	66	67	68	69	70
	90th	127	128	130	132	134	135	136	80	80	81	82	83	84	84
	95th	131	132	134	136	138	139	140	84	85	86	87	87	88	89
	99th	139	140	141	143	145	146	147	92	93	93	94	95	96	97

BP, blood pressure

* The 90th percentile is 1.28 SD, 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

Blood Pressure Levels for Girls by Age and Height Percentile

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	83	84	85	86	88	89	90	38	39	39	40	41	41	42
	90th	97	97	98	100	101	102	103	52	53	53	54	55	55	56
	95th	100	101	102	104	105	106	107	56	57	57	58	59	59	60
	99th	108	108	109	111	112	113	114	64	64	65	65	66	67	67
2	50th	85	85	87	88	89	91	91	43	44	44	45	46	46	47
	90th	98	99	100	101	103	104	105	57	58	58	59	60	61	61
	95th	102	103	104	105	107	108	109	61	62	62	63	64	65	65
	99th	109	110	111	112	114	115	116	69	69	70	70	71	72	72
3	50th	86	87	88	89	91	92	93	47	48	48	49	50	50	51
	90th	100	100	102	103	104	106	106	61	62	62	63	64	64	65
	95th	104	104	105	107	108	109	110	65	66	66	67	68	68	69
	99th	111	111	113	114	115	116	117	73	73	74	74	75	76	76
4	50th	88	88	90	91	92	94	94	50	50	51	52	52	53	54
	90th	101	102	103	104	106	107	108	64	64	65	66	67	67	68
	95th	105	106	107	108	110	111	112	68	68	69	70	71	71	72
	99th	112	113	114	115	117	118	119	76	76	76	77	78	79	79
5	50th	89	90	91	93	94	95	96	52	53	53	54	55	55	56
	90th	103	103	105	106	107	109	109	66	67	67	68	69	69	70
	95th	107	107	108	110	111	112	113	70	71	71	72	73	73	74
	99th	114	114	116	117	118	120	120	78	78	79	79	80	81	81
6	50th	91	92	93	94	96	97	98	54	54	55	56	56	57	58
	90th	104	105	106	108	109	110	111	68	68	69	70	70	71	72
	95th	108	109	110	111	113	114	115	72	72	73	74	74	75	76
	99th	115	116	117	119	120	121	122	80	80	80	81	82	83	83
7	50th	93	93	95	96	97	99	99	55	56	56	57	58	58	59
	90th	106	107	108	109	111	112	113	69	70	70	71	72	72	73
	95th	110	111	112	113	115	116	116	73	74	74	75	76	76	77
	99th	117	118	119	120	122	123	124	81	81	82	82	83	84	84
8	50th	95	95	96	98	99	100	101	57	57	57	58	59	60	60
	90th	108	109	110	111	113	114	114	71	71	71	72	73	74	74
	95th	112	112	114	115	116	118	118	75	75	75	76	77	78	78
	99th	119	120	121	122	123	125	125	82	82	83	83	84	85	86
9	50th	96	97	98	100	101	102	103	58	58	58	59	60	61	61
	90th	110	110	112	113	114	116	116	72	72	72	73	74	75	75
	95th	114	114	115	117	118	119	120	76	76	76	77	78	79	79
	99th	121	121	123	124	125	127	127	83	83	84	84	85	86	87
10	50th	98	99	100	102	103	104	105	59	59	59	60	61	62	62
	90th	112	112	114	115	116	118	118	73	73	73	74	75	76	76
	95th	116	116	117	119	120	121	122	77	77	77	78	79	80	80
	99th	123	123	125	126	127	129	129	84	84	85	86	86	87	88

Blood Pressure Levels for Girls by Age and Height Percentile (Continued)

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
11	50th	100	101	102	103	105	106	107	60	60	60	61	62	63	63
	90th	114	114	116	117	118	119	120	74	74	74	75	76	77	77
	95th	118	118	119	121	122	123	124	78	78	78	79	80	81	81
	99th	125	125	126	128	129	130	131	85	85	86	87	87	88	89
12	50th	102	103	104	105	107	108	109	61	61	61	62	63	64	64
	90th	116	116	117	119	120	121	122	75	75	75	76	77	78	78
	95th	119	120	121	123	124	125	126	79	79	79	80	81	82	82
	99th	127	127	128	130	131	132	133	86	86	87	88	88	89	90
13	50th	104	105	106	107	109	110	110	62	62	62	63	64	65	65
	90th	117	118	119	121	122	123	124	76	76	76	77	78	79	79
	95th	121	122	123	124	126	127	128	80	80	80	81	82	83	83
	99th	128	129	130	132	133	134	135	87	87	88	89	89	90	91
14	50th	106	106	107	109	110	111	112	63	63	63	64	65	66	66
	90th	119	120	121	122	124	125	125	77	77	77	78	79	80	80
	95th	123	123	125	126	127	129	129	81	81	81	82	83	84	84
	99th	130	131	132	133	135	136	136	88	88	89	90	90	91	92
15	50th	107	108	109	110	111	113	113	64	64	64	65	66	67	67
	90th	120	121	122	123	125	126	127	78	78	78	79	80	81	81
	95th	124	125	126	127	129	130	131	82	82	82	83	84	85	85
	99th	131	132	133	134	136	137	138	89	89	90	91	91	92	93
16	50th	108	108	110	111	112	114	114	64	64	65	66	66	67	68
	90th	121	122	123	124	126	127	128	78	78	79	80	81	81	82
	95th	125	126	127	128	130	131	132	82	82	83	84	85	85	86
	99th	132	133	134	135	137	138	139	90	90	90	91	92	93	93
17	50th	108	109	110	111	113	114	115	64	65	65	66	67	67	68
	90th	122	122	123	125	126	127	128	78	79	79	80	81	81	82
	95th	125	126	127	129	130	131	132	82	83	83	84	85	85	86
	99th	133	133	134	136	137	138	139	90	90	91	91	92	93	93

BP, blood pressure

* The 90th percentile is 1.28 SD, 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

Socioeconomic status scale

Modified Kuppusamy's Scale

education	score
Professional degree	7
B.A,B.Sc degree	6
Higher secondary	5
High school	4
Middle school	3
Primary school/literate	2
Illiterate	1

occupation	Score
Professional	10
Semiprofession	6
Clerical	5
Skilled worker	4
Semiskilled worker	3
Unskilled worker	2
Unemployed	1

Monthly per capita income	Score
Rs 3000 & above	10
2001-3000	6
1501-2000	5
1001-1500	4
501-1000	3
201-500	2
<200	1

Total score	Class
26-27	Class 1upper
16-25	Class 2upper middle
11-15	Class 3lower middle
5-10	Class 4 upper lower
<5	Class 5 lower